

FACT SHEET

EPSON'S PRECISIONCORE PRINTHEAD TECHNOLOGY



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AN EXPLANATION OF EPSON'S NEW PRINT TECHNOLOGY - PRECISIONCORE

PrecisionCore printhead technology is the product of one of the largest investments in research and development in Epson's history, merging the company's expertise in MEMS (Micro Electro Mechanical Systems) fabrication with advances in materials science.

With the flexibility to deliver high-speed solutions for commercial, industrial and office printing, PrecisionCore continues and extends Epson's tradition of providing renowned colour quality and output durability across the widest range of applications.

1) What is PrecisionCore

The heart of the technology is a next-generation print chip – MicroTFP. Encompassing both the proven TFP and new MicroTFP-based printheads, PrecisionCore embodies Epson's goal to bring the highest level of performance and value to the widest range of customers.

2) Background / history

The 2007 launch of Epson Thin Film Piezo (TFP) laid the foundation for PrecisionCore technology. The development of piezo crystal films just one micron thick—one hundredth the thickness of a human hair—allowed the maximum output of ink from the smallest print engine, allowing a big increase in the density of print nozzles. Combined with precise ink channels and nozzles, TFP printheads are able to place almost perfectly round dots on media with great precision.

PrecisionCore printhead technology builds on the company's materials science skills and MEMS manufacturing technology to extend the TFP accomplishment. The product of this advancement in technology is the PrecisionCore MicroTFP print chip.

3) Development & manufacturing process

Epson believes in creating its products from the ground up. One of Epson's key strengths lies in monozukuri, which translates as the "the art and science of manufacturing". This gives Epson greater flexibility in designing, creating and refining its own products and technologies.

PrecisionCore



Key Facts

- What's new?
- The MicroTFP print chip and its piezo actuator, ink flow path and electronics
- The linehead print configuration
- MEMS manufacturing techniques
- Two production lines and assembly line robotics

PrecisionCore, Epson's most advanced microelectronic print head technology, powers the industry-leading output quality that Epson is renowned for at the high speeds required for enterprise, commercial and industrial printing.

In line with this approach, Epson recently announced the completion of two new inkjet printhead production lines in Japan, costing 125 million dollars. This is one of the biggest investments in the company's history.

These unique facilities combine the company's skill and expertise in piezo materials science, silicon wafer-based MEMS fabrication and high-precision processing. Epson invented the manufacturing processes, then designed and created much of the equipment in-house.

These new production lines make possible the creation of the new MicroTFP print chip and a whole range of new printheads.

4) Technologies

PrecisionCore is Epson's most advanced printhead technology.

4.1) Thin Film Piezo (TFP)

A piezo crystal has the property that it flexes or changes shape when an electrical voltage is applied to it. This motion is the driving force of the tiny "ink pumps" in every nozzle of Epson's printheads. In general, the thinner the piezo element, the more it flexes.

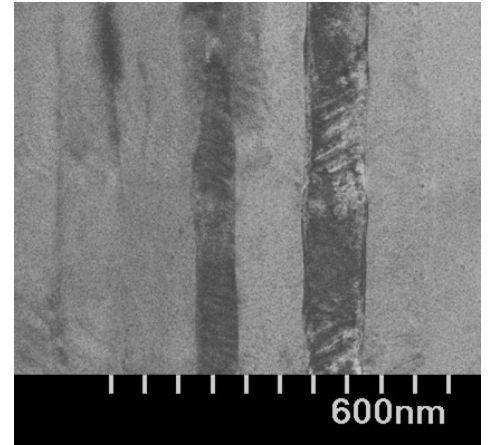
Conventional piezo printheads are created by precisely machining pieces of piezo crystal. For its PrecisionCore Thin Film Piezo (TFP) print chips, Epson uses a proprietary process to form a dense PZT piezo crystal element just one micron thick on a silicon wafer, resulting in outstanding actuator performance.

MicroTFP doubles the piezo actuator's flexing power compared to the original TFP printhead. This, together with a redesign of the ink flow path, electronics, and other components, allows greater miniaturisation.

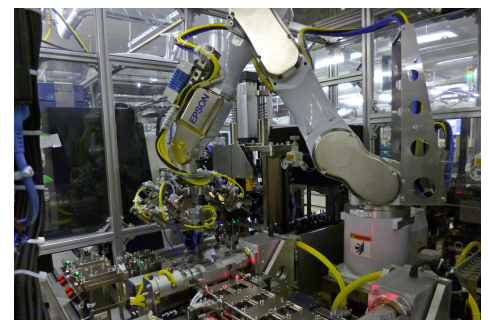
By densely packing precision micro piezo actuators and ink nozzles onto silicon wafers, the width of the print chip has been reduced, with two key results: efficient production, and improved scalability.

4.2) Micro Electro Mechanical Systems (MEMS) Manufacturing

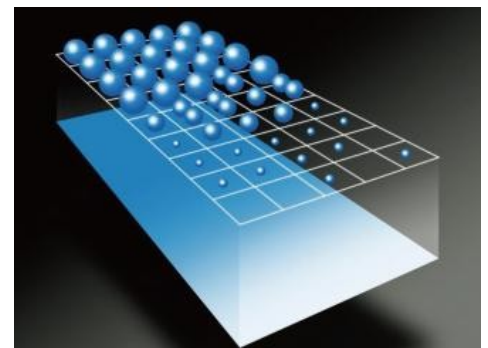
Below you can see magnified images of the ink cavities, piezo actuators, and nozzles from the MicroTFP print chip, spaced at 84.7 microns apart. All are created using Epson's MEMS manufacturing techniques. MEMS technology builds tiny mechanical systems on silicon or glass using semiconductor IC chip fabrication techniques, and is used to create accelerometers for automobiles and mobile phones, parts used in hard disk drives, and other devices. By merging MEMS processes with its advanced piezo material science, Epson has been able to create microscopic, high-performance actuators and form high-accuracy ink channels, enabling precise, high-speed ink ejection.



Electron microscope image of a PZT piezo crystal cross-section

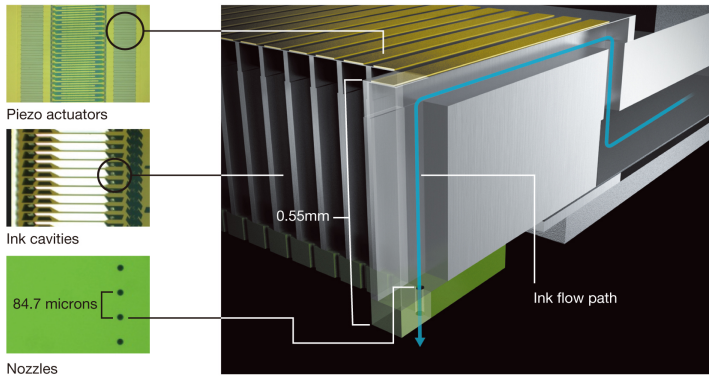


Epson robots on the production lines



Variable dot sizes produce smoother output

For more information
please visit: www.epson.eu



4.3) Precision Assembly

These print chips are then connected to ink reservoirs, filters and electronics, and finally encased on fully-automated assembly lines featuring Epson's leading-edge factory automation, with almost no human intervention.

Six-axis scalar robots work in unison with proprietary image processing and assembly technology to produce a steady flow of encased chip assemblies, which form the platform for the respective print heads.

5) The benefits

PrecisionCore printhead technology delivers Epson's renowned, industry-leading output quality at high speed.

5.1) Speed

Inch for inch, the high-resolution Epson print chips are one of the fastest inkjet printing technologies in the world. PrecisionCore piezo elements each fire nearly 50,000 times per second. Alongside this, the new linehead SurePress L-6034VW runs between three and ten times faster than the multi-pass serial printhead SurePress L-4033AW because of its 52,800 nozzles in a linehead formation.

To make this happen, high-performance data transfer and controller integrated circuits are also required. Each printer relies on complex image processing to determine the optimum combination of inks and drop sizes to achieve the best quality image, and these calculations are usually performed on these powerful, Epson-designed and built integrated circuits. To give you an idea of the computing power required, the SurePress L-6034VW, printing at 600x600dpi on paper flying past at 15 meters (590 inches) per minute, requires almost two and a half billion decisions about whether to fire a drop and what size drop, every second.

PrecisionCore also uses its nozzles efficiently. The printhead design allows PrecisionCore to deliver high-speed media coverage by selecting a large drop size at a fast firing rate. PrecisionCore nozzles can also reconfigure themselves in around 1/10,000 of a second to deliver small, round drops, allowing for sharp text, smooth edges and gradations, as well as fast area fills.

5.2) Quality

It's the combination of speed and quality that allows the PrecisionCore to stand head and shoulders above other printing technologies. PrecisionCore has up to triple the nozzle density of conventional Epson piezo printheads with a native output at either 600 or 720dpi per print chip. These nozzles are roughly 20 microns in diameter and deliver small, round, repeatable dots about 40 microns across. This dot precision is particularly important for creating sharp text and fine lines.

Another of PrecisionCore's strengths, one that allows it to achieve such high-quality output, is its powerful, high-displacement piezo element that enables it to deliver both large and small drop volumes even at high resolution. PrecisionCore printhead nozzles can deliver drops as small as 1.5 picoliters (pl) (1.5 trillionths of a litre), they can also deliver drops of up to 32.5 pl. Its variable drop architecture enables it to select from several different dot sizes with each pulse of the nozzle for superior results. The efficient nozzles of PrecisionCore can efficiently and precisely deliver the most appropriate amount of ink to achieve high-quality, high-speed printing.

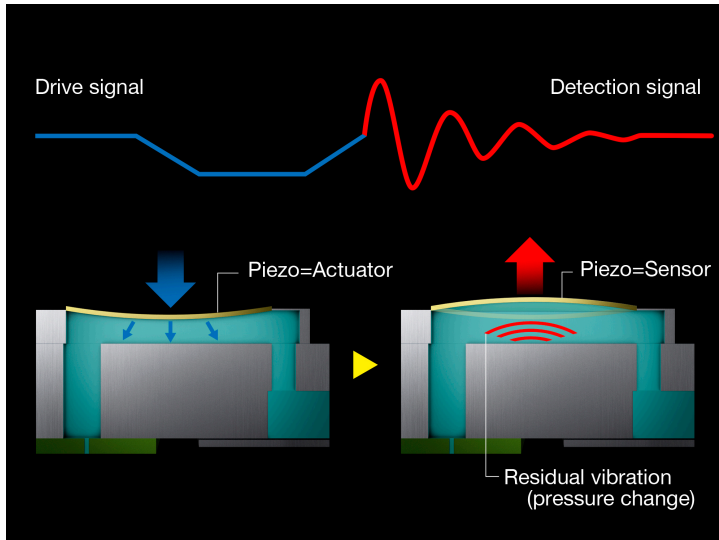
Adding variable drop sizes to the consistently precise drop control means that perceived resolution of output from a PrecisionCore system can be much greater than the standard dpi resolution measurement.

The levels of grayscale used in an image contribute considerably to its perceived quality. Each of these dot sizes ejected by the PrecisionCore head represents an available level of grayscale, with the smallest dots providing gradation equivalent to a much higher resolution.

5.3) Reliability

PrecisionCore introduces a new system that uses the power of the piezo crystal itself to raise reliability, one that is only possible in a piezo printhead.

When voltage is applied to the piezo element, it flexes, acting as an actuator (the pump that ejects the ink). Conversely, when a piezo element is flexed, it actually generates a voltage. Because of this characteristic, the PrecisionCore piezo element can be both an extremely powerful ink pump and a highly-sensitive sensor. By using this capability, the piezo element can detect in milliseconds whether it is firing normally, if an air bubble has interrupted firing, or if rising ink viscosity may cause issues, all without having to eject any ink. It has the ability to self-diagnose its health almost instantly. This technology has the potential to be used in a wide variety of Epson printers.



5.4) Ink and media flexibility

PrecisionCore's micro-mechanical firing element avoids the material limitations faced by heat-based systems, enabling Epson's ink chemists to select from a wider range of critical materials, and to use them in higher concentration. This delivers a number of benefits.

First, it allows for more colourful and durable ink formulations. Ink formulations that contain higher concentrations of colourants and binders than heat-based inkjet systems mean brighter, more vibrant, and more durable output. PrecisionCore enables output that has superior colour with dark blacks, because of its ability to deliver more colourant per dot volume, and more durable output because of its ability to deliver inks with a higher percentage of binder. This allows Epson printers to produce the widest range of colour (gamut) without having to resort to papers with specialised coatings. The high pigment ratio and quick-drying nature of the Epson ink enables more of the critical colorant to remain on or near the surface of the paper.

Second, it also allows printing on a much wider range of substrates. Epson inks contain functional additives with properties enabling inks to adhere to a wider range of materials. Carrier flexibility of the PrecisionCore print chips is another factor that contributes to media flexibility. PrecisionCore can print with aqueous pigment and dye, eco-solvent, resin, sublimation, oil-based or UV curable inks.

UV inks are notoriously difficult to use reliably in inkjet systems, but the SurePress L-6034V successfully uses them to print on a wider range of label materials than competing systems. The results can exceed the gamut and Pantone coverage of established four-colour commercial liquid toner systems because of their more colourful pigment particles and more transparent resin coatings. This large gamut and optical colour density is achieved without the need for pre-coating or premium-priced substrates.

5.5) Scalability

PrecisionCore is a scalable technology suited for products ranging from industrial systems such as large-scale label presses to desktop printers. Its modularity allows PrecisionCore print chips to be arrayed in both moving serial printhead and fixed linehead configurations.

The new PrecisionCore linehead assembly brings 52,800 nozzles together in the SurePress L-6034. Its 66 chips deliver continuous single-pass speeds of 15 meters per minute over 33cm (13 inch) wide media, in six edge-to-edge, fixed lineheads.

6) Specifications

PrecisionCore	TFP print chip	MicroTFP print chip
Technology	Thin Film Piezo inkjet technology	
Print chip construction	MEMS (Micro electro mechanical system) All-silicon ink path and nozzle plate	
Compatible ink types	Aqueous, solvent, resin, UV curable	
Operating frequency	Up to 50kHz	
Drop size	1.5 – 32.5 picoliters (Multi drop size technology)	
Dimensions (L x W)	29.7 x 8mm	38.5 x 6.8mm
Nozzle line length	25.4mm (1 inch)	33.8mm (1.33 inch)
Lines per print chip	2	2
Nozzles per line	360	400
Nozzles per print chip	720	800
Nozzles per inch	720	600
Nozzle pitch per chip (2 nozzle lines)	35.2µm (720dpi)	42.3µm (600dpi)

7) The future

Unlike heat-based printing technologies, piezo is able to jet some exotic fluids (pharmaceuticals, conductive materials, etc.) that could be the foundation for tomorrow's breakthrough research. Piezo even allows single-pass micro-deposition of functional fluids used in manufacturing products such as colour filters for LED panels, printable electronics and LCD displays.

The scalability of PrecisionCore will allow Epson to fully leverage its historical strengths of ink flexibility and printhead durability in new markets. The flexibility will bring the ability to fire high-density pigments, solvents, UV and almost any other ink type required to new customers. And the durability of the piezo element and the all-silicon print chip will provide them with long-life performance.

The capabilities of the PrecisionCore print chip enable us to create tailor-made high-performance printing systems for every major customer segment - from the production printing specialist through to the business person - simply by arranging these modules in various formations.

With the advancements in the PrecisionCore printhead, in the very near future, Epson's piezo inkjet printing technology has the potential ability to print almost any liquid on almost any substrate with extreme precision.